Signal Processing with Simulink

Training Objectives

This three-day course, targeted toward new users of Simulink®, uses basic modeling techniques and tools to demonstrate how to develop Simulink block diagrams for signal processing applications. Topics include:

- What is Simulink?
- Using the Simulink interface
- Modeling single-channel and multi-channel discrete dynamic systems
- Implementing sample-based and frame-based processing
- Modeling mixed-signal (hybrid) systems
- Developing custom blocks and libraries
- Modeling condition-based systems
- Performing spectral analysis with Simulink
- Integrating filter designs into Simulink
- Modeling multirate systems
- Incorporating external code
- Automating modeling tasks

Prerequisites

MATLAB Fundamentals and basic knowledge of digital signal processing.

Products

- MATLAB®
- DSP System Toolbox™
- Fixed-Point Toolbox™
- Simulink

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Course Outline

Day 1 of 3

What is Simulink? (0.5 hrs)

Objective: Get an introduction to Simulink.

- What is Simulink?
- Benefits of using Simulink
- Simulink add-ons
- A look at a Simulink model

Creating and Simulating a Model (2.0 hrs)

Objective: Explore the Simulink interface and block libraries. Build a simple model and analyze the simulation results.

- Creating and editing a Simulink model
- Defining system inputs and outputs
- Simulating the model and analyzing results

Modeling Discrete Dynamic Systems (2.0 hrs)

Objective: Model discrete dynamic systems, and visualize frame-based signals and multichannel signals using a scope.

- Modeling a discrete system with basic blocks
- Finding sample times of block outputs
- Using frames in your model
- Using buffers
- Frames vs. multichannel signals
- Viewing frame-based signals
- Behavior of delay blocks with frame-based signals
- Multichannel frame-based signals

Modeling Logical Constructs (1.0 hrs)

Objective: Model logical expressions. See how zero-crossing detection is used in Simulink and model simple logic in Simulink using MATLAB code.

- Modeling logical expressions
- Modeling conditional signal routing
- Understanding zero-crossing detection
- Modeling with the MATLAB Function block

From Algorithm to Model (1.5 hrs)

Objective: Create a model from an algorithm specification.

- Modeling from algorithmic specifications
- Iterative algorithm development through modeling and simulation
- Verifying models against specified algorithms

Day 2 of 3

Mixed-Signal Models (1.5 hrs)

Objective: Model mixed-signal systems.

- What is a mixed-signal model?
- Modeling an ADC with aperture jitter and nonlinearity
- Case study: Modeling TI's ADS62P29 ADC

Simulink Solvers (1.0 hrs)

Objective: Choose the right solver for a Simulink model.

- Understanding the Simulink solver
- Solving simple models
- Solving models with discrete and continuous states
- Solving models with multiple rates
- Fixed-step and variable-step solvers
- Choosing a continuous-state system solver
- Handling zero crossings
- Handling algebraic loops

Subsystems and Libraries (1.5 hrs)

Objective: Create custom blocks in Simulink, apply masks, and develop custom libraries.

- Creating subsystems
- Understanding virtual and atomic subsystems
- Using a subsystem as a model component
- Masking subsystems
- Creating custom block libraries
- Working with and modifying library blocks
- Adding custom libraries to the Simulink Library Browser
- Creating configurable subsystems

Conditional Subsystems (0.75 hrs)

Objective: Model systems with parts that are executed conditionally.

- Conditionally executed subsystems
- Modeling condition-driven systems with enabled subsystems
- Modeling condition-driven systems with triggered subsystems
- Working with an example using the AGC model

Spectral Analysis (2.25 hrs)

Objective: Perform spectral analysis in the Simulink environment, and use spectrum computation in an algorithm.

- Performing spectral analysis with the Spectrum Scope block
- Choosing spectral analysis parameters
- Analyzing power spectrum of a motor noise
- Building a spectral classifier of speech
- Determining the frequency response of a discrete system

Day 3 of 3

Designing and Applying Filters (2.5 hrs)

Objective: Incorporate filters in a model, and explore different ways filters can be designed and implemented in a Simulink model.

- Designing filters in Simulink
- Converting filters to fixed point

Multirate Systems (2.0 hrs)

Objective: Model multirate systems. Resample data and explore multirate filter blocks.

- Modeling multirate systems
- Exploring blocks for multirate signal processing
- Resampling oversampled data

- Designing and implementing anti-imaging and anti-aliasing filters
- Using multirate filter blocks
- Case study: Converting professional audio to CD format
- Converting the design to fixed point

Incorporating External Code (1.0 hrs)

Objective: Import or incorporate custom or external MATLAB and C code into a Simulink model.

- Working with custom and external code considerations
- Incorporating MATLAB code with the MATLAB Function block
- Incorporating C code with Legacy Code Tool

Combining Models into Diagrams (1.0 hrs)

Objective: Explore model integration, an important topic for large-scale projects in which several developers are developing different portions of a large system.

- Exploring model referencing and subsystems
- Setting up a model reference
- Setting up model reference arguments
- Exploring model reference simulation modes
- Viewing signals in referenced models
- Browsing the model reference dependency graph

Automating Modeling Tasks (0.5 hrs)

Objective: Control and run Simulink models from the MATLAB command line.

- Automating test runs
- Checking and modifying parameter settings
- Finding blocks with specific parameter values
- Constructing and modifying block diagrams

Appendix C: Simulink Fixed Point (1.0 hrs)

Objective: Get an introduction to Simulink Fixed Point™ and fixed-point mathematics fundamentals. Explore fixed-point scaling and the Fixed-Point Settings interface.

- Simulink Fixed Point
- Simulink built-in data types
- Fixed-point data types
- Fixed-point concepts and arithmetic
- Fixed-point scaling and overflow handling
- Fixed-point rules for targeting embedded processors
- Using the Fixed-Point Settings interface